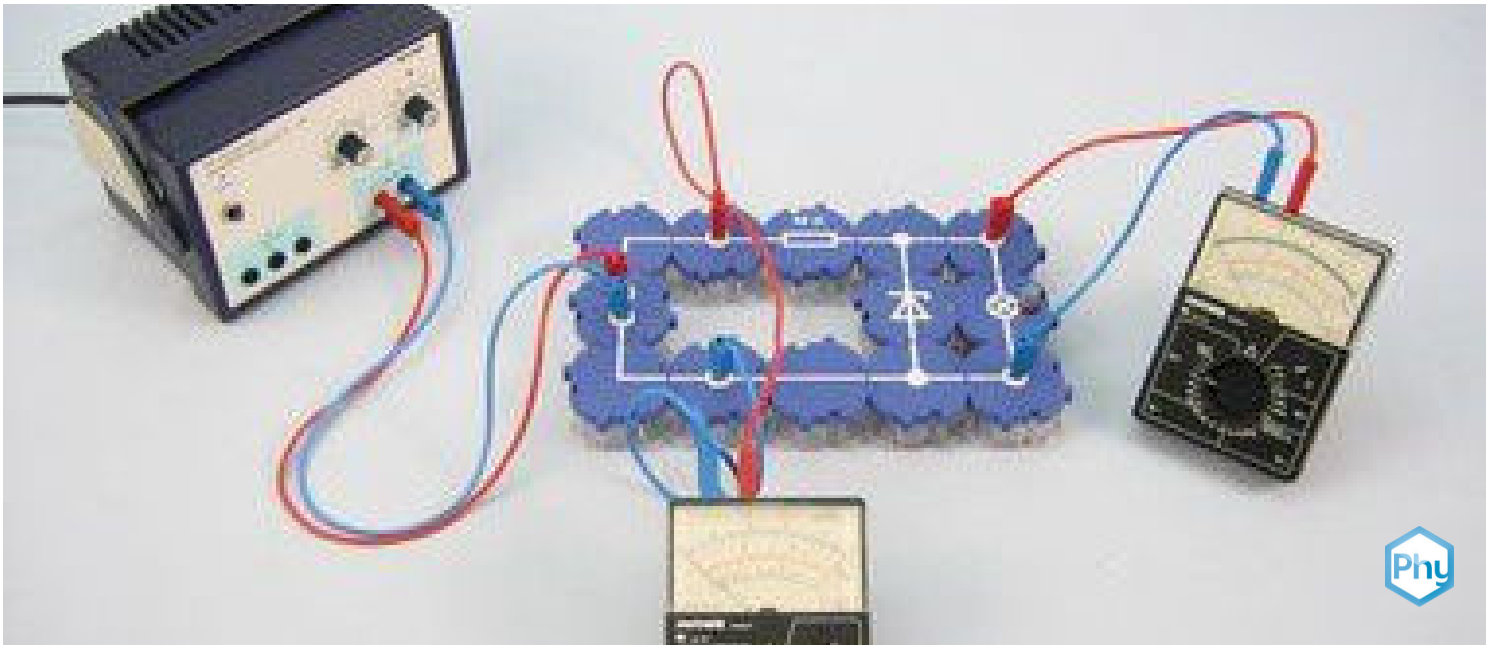
The Zener diode as voltage stabiliser



The students should use the experiment to see how a Z-diode (Zener Diode) can be used as a voltage stabiliser.

Physics > Electricity & Magnetism > Electronics

Difficulty level	Group size	Preparation time	Execution time
medium	2	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/63170e429ebaee00039a3c88

PHYWE
Robert-Bosch-Breite 10
37079 Göttingen
Tel.: 0551 604 - 0
Fax: 0551 604 - 107
info@phywe.de
www.phywe.de

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Teacher information

Application

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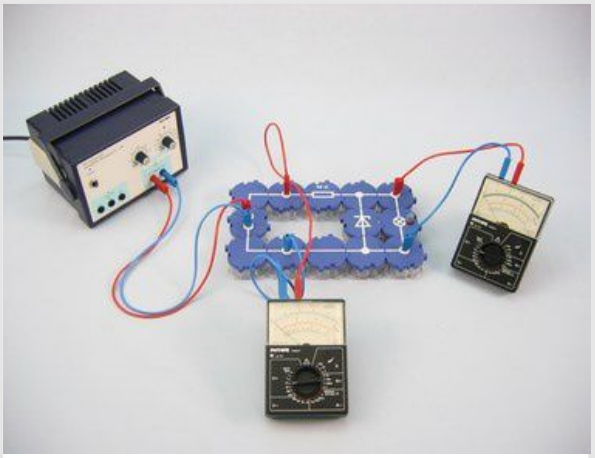

Experimental setup

Z-diodes are silicon diodes with high doping of the p- and n-region. They behave like ordinary Si diodes in the forward direction. When a voltage is applied in the reverse direction, a high electric field strength is generated in the very narrow boundary layer. When a voltage dependent on the selected doping, the breakdown voltage, is exceeded, charge carrier pairs are released under the influence of the electric field, resulting in a strong increase in current intensity. This reduces the diode resistance. If the external voltage is increased further, the diode current rises sharply and produces an increasing voltage drop at the series resistor, while the voltage at the diode rises only very slightly.

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Other teacher information (1/2)

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Prior knowledge

Students should be familiar with how a Z-diode works.

Principle

The steep slope of the current-voltage characteristic of a Z-diode above the breakdown voltage enables its use for stabilising small DC voltages. When the input voltage is increased above the breakdown voltage, the current increases steeply, whereby the resistance of the diode decreases more and more. Therefore, the voltage across the Z-diode remains approximately constant.

Other teacher information (2/2)

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Learning objective

The students should use the experiment to see how a Z-diode can be used as a voltage stabiliser.

Tasks

Investigate the operation of a voltage stabiliser with a Z-diode.

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Safety instructions

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The general instructions for safe experimentation in science lessons apply to this experiment.

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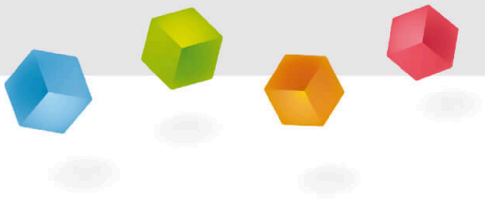

Student information

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Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
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Motivation

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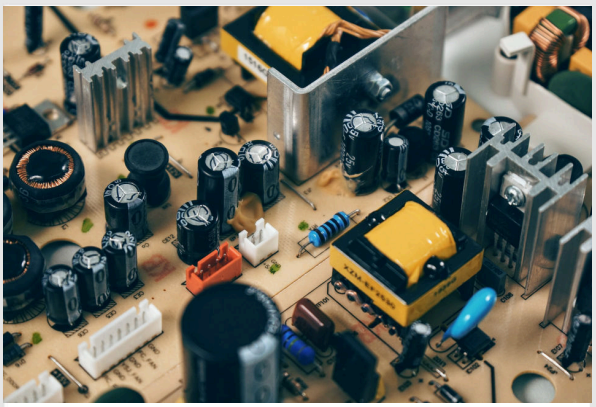
A diode is an electronic component that allows current to pass in one direction and blocks the flow of current in the other direction.

A Z-diode (also Zener diode) is a diode that is designed to be operated permanently in the reverse direction in the breakdown voltage range. The level of this breakdown voltage UBR is the main characteristic of a Z-diode and is specified in the data sheet. This is achieved by a heavily doped p+ and a heavily doped n+ layer. The strong recombination of both layers leads to a very small junction thickness and thus to high field strengths in the junction region.



Electronic components

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Equipment

Position	Material	Item No.	Quantity
1	Straight connector module, SB	05601-01	1
2	Angled connector module, SB	05601-02	2
3	T-shaped connector module, SB	05601-03	2
4	Interrupted connector module with sockets, SB	05601-04	1
5	Straight connector module with socket, SB	05601-11	1
6	Angled connector module with socket, SB	05601-12	1
7	Socket module for incandescent lamp E10, SB	05604-00	1
8	Resistor module 50 Ohm, SB	05612-50	1
9	Z-diode module ZF4.7, SB	05652-00	1
10	Connecting cord, 32 A, 250 mm, red	07360-01	1
11	Connecting cord, 32 A, 250 mm, blue	07360-04	1
12	Connecting cord, 32 A, 500 mm, red	07361-01	2
13	Connecting cord, 32 A, 500 mm, blue	07361-04	2
14	Filament lamps 4V/0.04A, E10, 10	06154-03	1
15	PHYWE Power supply, 230 V, DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1
16	PHYWE Analog multimeter, 600V AC/DC, 10A AC/DC, 2 MΩ, overload protection	07021-11	2

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Set-up

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- Set up the experiment according to Fig. 1 and Fig. 2. Select the measuring range 10 V- for both measuring instruments. Make sure the polarity is correct.

Note: If only one measuring instrument is available, the *U*1 is determined from the scale on the power supply unit.

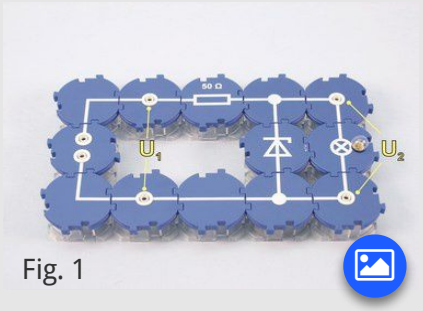

Fig. 1

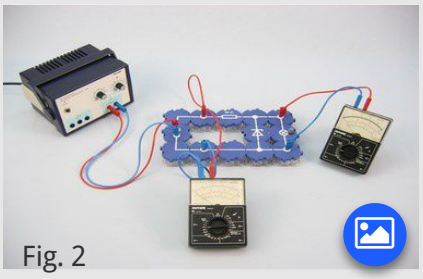

Fig. 2

Procedure

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- **Task 1**: Switch on the power supply unit and increase the voltage *U*1 from 0 V to 10 V in steps of 1 V. Determine the measured values for *U*1 and *U*2 and enter them in Table 1 in the report.
- **Task 2**: Remove the measuring instrument for *U*1 from the circuit. Vary the applied voltage *U*1 several times in the range from 8 V to 10 V and observe the measuring instrument and the bulb. Note down the observations in the report.
- **Task 3:** Set the voltage on the power supply unit to 10 V. Screw the bulb in and out several times. Observe the meter and note your observation.
- Switch off the power supply unit.

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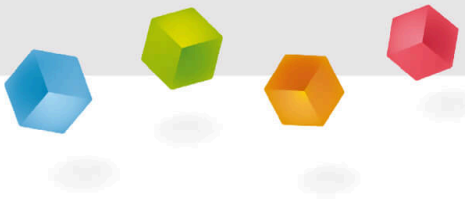

Report

Result

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U_1 [V]	U_2 [V]
1	
2	
3	
4	
5	

U_1 [V]	U_2 [V]
6	
7	
8	
9	
10	

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Observation (1/2)

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Write down your observations on the second task.

Observation (2/2)

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Make a note of your observations on the 3rd task.

The bulb lights up: $U_2 =$ V

The bulb does not light up: $U_2 =$ V

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Task (1/3)

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Compare the change U_2 of the output voltage with the change U_1 of the input voltage in the range 8 V ≤ U_1 ≤ 10 V.

Task (2/3)

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Specify at which input voltage the stabilising function of the Z-diode starts.

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Task (3/3)

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How does the circuit behave when the load is changed?

Show solutions | Repeat | Export text

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